appo
应用编排器appo是**负责编排应用生命周期维护操作**的核心模块。
v1.2版本说明 http://docs.edgegallery.org/zh_CN/release-v1.2/Projects/MECM/MECM_Architecture_en.html#application-orchestrator

接口设计

appo主要涉及以下接口：
Appo Interfaces

- Get All Application Instances
- Get Application Instance
- Create AppInstance //创建app实例
- Get App Instance Information
- Instantiate Application //app实例化
- Delete Application Instance
- Get Query Kpi
- Get Mep Capabilities
- Get Mep Capability
- Create Batch
- Batch instantiate //批量实例化
- Batch terminate
- Batch Query
- Queries liveness & readiness
- Create AppRule Config //创建appRule config
- Update AppRule Config
- Delete AppRule Config
- Get AppRule Config Status
- Synchronizes application instance info from edge
- APPO Open Api Swagger

下面以创建实例和实例化实例两个接口来进行分析：

创建实例

入口代码

创建实例的接口为 /appo/v1/tenants/{tenant_id}/app_instances, 实现入口位于mecm-appo/src/main/java/org/edgegallery/mecm/appo/apihandler/AppOrchestratorHandler.java：

```
@ApiOperation(value = "Creates application instance", response = AppoResponse.class)
@PostMapping(path = "/tenants/{tenant_id}/app_instances", produces = MediaType.APPLICATION_JSON_VALUE)
@ApiResponses(value = {@ApiResponse(code = 201, message = "request accepted ", response = AppoResponse.class),
@ApiResponse(code = 500, message = "internal server error", response = String.class)
})
@PreAuthorize("hasRole('MECM_TENANT') || hasRole('MECM_ADMIN')")
public ResponseEntity<AppoResponse> createAppInstance(
@ApiParam(value = "access token") @RequestHeader("access_token") String accessToken,
@ApiParam(value = "tenant id") @PathVariable("tenant_id")
 @Pattern(regexp = Constants.TENENT_ID_REGEX) @Size(max = 64) String tenantId,
 @ApiParam(value = "create application instance")
 @Valid @RequestBody CreateParam createParam) {
 logger.debug("Application create request received...");
 //createParam除了包含appPackage,appName,appId,mep服务等信息，还包含了mecHost，即边缘节点ip
 return appoService.createAppInstance(accessToken, tenantId, createParam);
 }
```

其中createParam的结构如下：

```
public abstract class AppInstanceParam {

 @NotEmpty(message = "Package ID is mandatory")
 @Size(max = 64)
 @Pattern(regexp = APP_PKG_ID_REGX, message = "Package ID is invalid. It must be lowercase letters or digits with "
 + "length of 32/64 characters.")
 private String appPackageId;

 @NotEmpty(message = "Application name is mandatory")
  @Size(max = 128)
  @Pattern(regexp = APP_NAME_REGEX, message = "App name is invalid. It must start and end with alpha numeric "
  + "character and special characters allowed are hyphen and underscore.")
  private String appName;

  @NotEmpty(message = "Application instance ID is mandatory")
  @Size(max = 64)
  @Pattern(regexp = APPD_ID_REGEX, message = "Application instance ID is invalid. It must be lowercase letters or "
  + "digits with length of 32 characters.")
  private String appId;

  @NotEmpty(message = "Application instance description is mandatory")
  @Size(max = 256)
  private String appInstanceDescription;

  @Size(max = 10, message = "capabilities exceeds max limit 10")
  private List<@Valid String> hwCapabilities = new LinkedList<>();
}
public final class CreateParam extends AppInstanceParam {

  @NotEmpty(message = "MEC host is mandatory")
  @Size(max = 15)
  @Pattern(regexp = HOST_IP_REGX, message = "MEC host IP is invalid")
  private String mecHost;
}
```

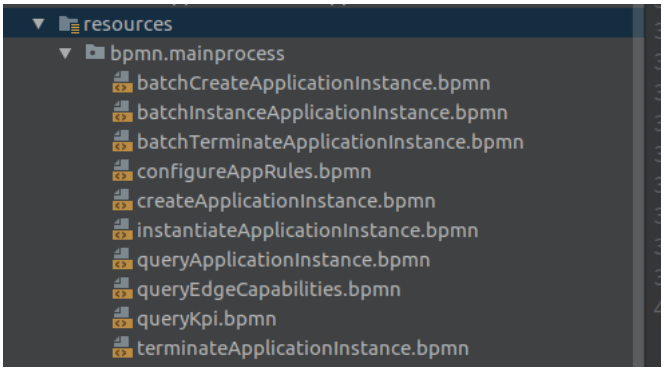
继续看createAppInstance的实现：

```
@Override
 public ResponseEntity<AppoResponse> createAppInstance(String accessToken, String tenantId,
 CreateParam createParam) {
 LOGGER.debug("Application create request received...");
```

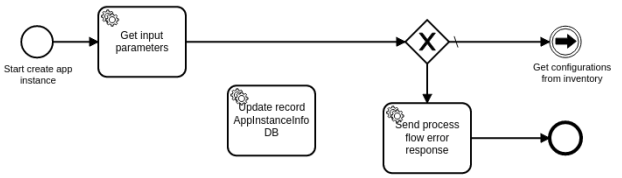
```
//re-use check,同租户下，不能在同一mecHost上创建同名app
//...省略
//创建工作流入参
Map<String, String> requestBodyParam = new HashMap<>();
requestBodyParam.put(Constants.TENANT_ID, tenantId);
 requestBodyParam.put(Constants.APP_PACKAGE_ID, createParam.getAppPackageId());
 requestBodyParam.put(Constants.APP_ID, createParam.getAppId());
 requestBodyParam.put(Constants.APP_NAME, createParam.getAppName());
 requestBodyParam.put(Constants.APP_DESCR, createParam.getAppInstanceDescription());
 requestBodyParam.put(Constants.MEC_HOST, createParam.getMecHost());
 String hwCapabilities =
 createParam.getHwCapabilities().stream().map(Object::toString).collect(Collectors.joining(","));
 requestBodyParam.put(Constants.HW_CAPABILITIES, hwCapabilities);

 LOGGER.debug("Create instance input parameters: {}", requestBodyParam);
 String appInstanceID = UUID.randomUUID().toString();
 requestBodyParam.put(Constants.APP_INSTANCE_ID, appInstanceID);
 requestBodyParam.put(Constants.ACCESS_TOKEN, accessToken);
 //写DB，创建app instance记录
 AppInstanceInfo appInstInfo = new AppInstanceInfo();
 appInstInfo.setAppInstanceId(appInstanceID);
 appInstInfo.setAppPackageId(createParam.getAppPackageId());
 appInstInfo.setTenant(tenantId);
 appInstInfo.setAppId(createParam.getAppId());
 appInstInfo.setAppName(createParam.getAppName());
 appInstInfo.setAppDescriptor(createParam.getAppInstanceDescription());
 appInstInfo.setMecHost(createParam.getMecHost());
 appInstInfo.setOperationalStatus(Constants.OPER_STATUS_CREATING);
 appInstanceInfoService.createAppInstanceInfo(tenantId, appInstInfo);

 requestBodyParam.put(Constants.APPRULE_TASK_ID, appInstanceID);
 //写DB，给app instance记录创建关联的app rule
 AppRuleTask appRuleTaskInfo = new AppRuleTask();
 appRuleTaskInfo.setAppRuleTaskId(appInstanceID);
 appRuleTaskInfo.setTenant(tenantId);
 appRuleTaskInfo.setAppInstanceId(appInstanceID);
 appRuleTaskInfo.setConfigResult(APP_RULE_PROCESSING);
 appInstanceInfoService.createAppRuleTaskInfo(tenantId, appRuleTaskInfo);
 //执行BPMN工作流，流程名称为createApplicationInstance，流程入参requestBodyParam
 processflowService.executeProcessAsync("createApplicationInstance", requestBodyParam);
 Map<String, String> response = new HashMap<>();
 response.put(Constants.APP_INSTANCE_ID, appInstanceID);
 return new ResponseEntity<>(new AppoResponse(response), HttpStatus.ACCEPTED);
 }
```

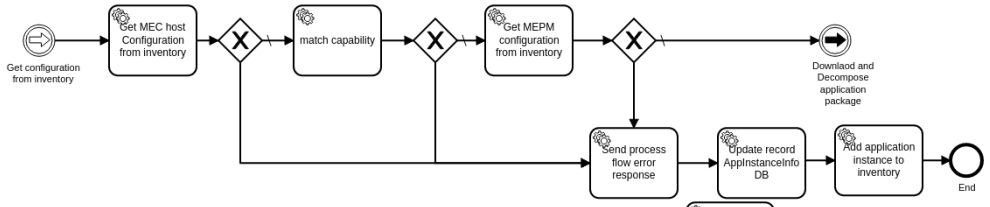
业务流程

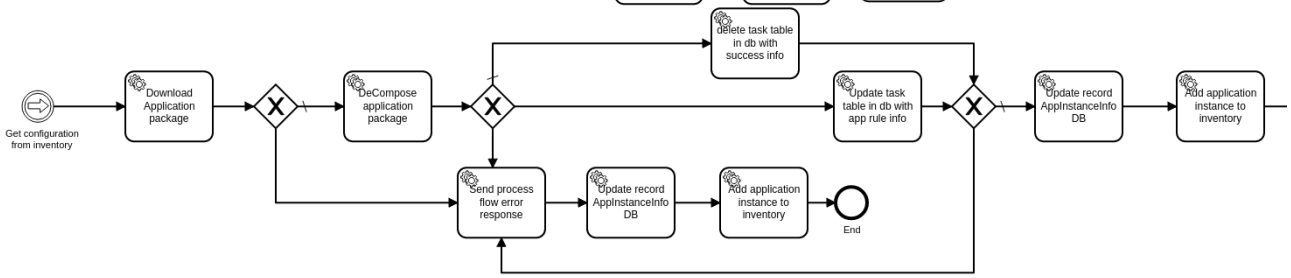
appo在业务流程处，引入了基于BPMN的工作流Camunda https://camunda.com/，其流程定义位于：



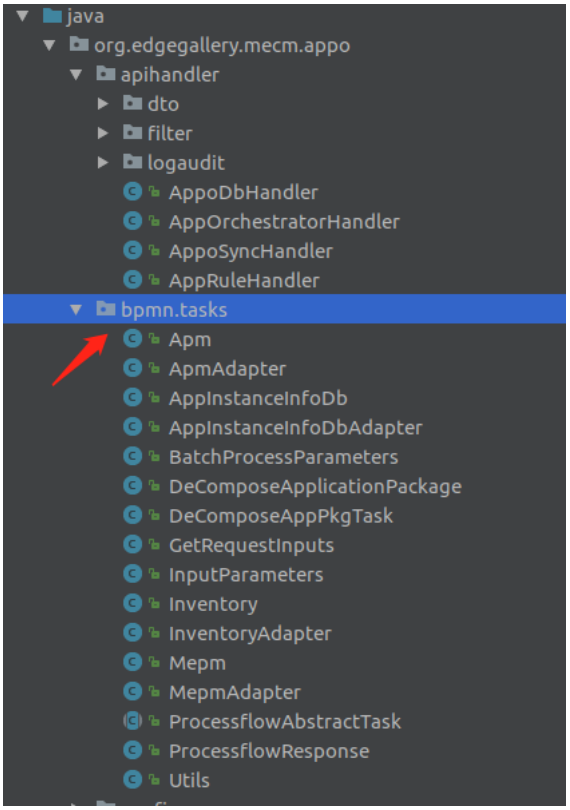
在安装完Camunda插件后，打开createApplicationInstance.bpmn插件，可查看其流程图：







在定义的每一个流程节点上，通过为节点和网关定义行为，执行具体的业务代码，业务代码位于:



创建app处具体包括3个流程，分别为:

1. Create app instance
2. Get configuration from inventory
3. DownloadAndDecompose （注，这里不知道是不是流程名写错了）

格式:

[节点

代码入口，节点入参，业务逻辑]

Create app instance

1. Get input parameter

bpmn.tasks.GetRequestInputs requestAction=CreateAppInstance 向DelegateExecution赋值各种AppInstance信息，DelegateExecution即为流程上下文，如果出错，执行错误流程

2. Exclusive 网关

无 无 执行节点网关，如果出错，执行错误流程bpmn.tasks.ProcessflowResponse，返回失败。否则，执行成功的话link到inventory流程

错误处理流程：

1. Send process flow error response

bpmn.tasks.ProcessflowResponse responseType=failure 从上下文中解析reponse,如果失败，将流程code和resp写入上下文，打印日志

Get configuration from inventory

1. Get MEC host Configuration from inventory

bpmn.tasks.InventoryAdapter inventory=mecHost 根据DelegateExecution中的mecHost ID,调用inventory服务获取mechost上的信息（包括applcm_ip，app_rule_manager_ip，mec能力列表hw_capabilities_list），并写入上下文，如果成功，执行match capability，错误执行错误流程。

2. match capability

bpmn.tasks.Utils utilType=matchCapabilities 对app的需求能力列表和mec host提供的能力列表做比对。失败进入错误流程，成功继续

3. Get MEPM configuration from inventory

tasks.InventoryAdapter inventory=mepm 根据入参，执行getMepm函数，具体为根据上下文中的mepm_ip和tenant_id，调用inventory接口/inventory/v1/mepms/{mepm_ip}，获取mepmPort后写入上下文，成功后link到DownloadAndDecompose，错误执行错误流程。

错误处理流程：

1. Send process flow error response

bpmn.tasks.ProcessflowResponse responseType=failure 向上下文写入错误码和resp

2. Update record AppInstanceInfo DB

bpmn.tasks.AppInstanceInfoDbAdapter operationType=update，operational_status=Create failed 通过上下文从DB中获取appInstance记录后，更新记录状态

3. Add application instance to inventory

bpmn.tasks.InventoryAdapter inventory=application,operType=ADD,status=Create failed 从上下文读值mecHost、tenantId、appInstanceId，appName和appPackageId,构造请求，调用inventory接口POST /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps，其中status为Create failed

DownloadAndDecompose

1. Download Application package

tasks.ApmAdapter operationType=download 从上下文获取appPkgId,调用apm服务接口 GET /apm/v1/tenants/{tenant_id}/packages/{app_package_id}/download ，返回app包的文件对象，然后copy到以appInstanceId为粒度的指定目录下{base}/{appInstanceId}/xxx，成功继续，失败进入错误处理流程。

2. DeCompose application package

tasks.DeComposeApplicationPackage 无参数 解压appPkg包，解析TOSCA.meta，从properties字段获取app_rules后写入上下文。失败进入错误处理流程，成功继续。

接下来根据appRules的值，从任务delete task table in db with success info和Update task table in db with app rule info中选其一执行。当上下文中app_rules的值不为空时：

3.1 Update task table in db with app rule info

tasks.AppInstanceInfoDbAdapter operationType=updateAppRuleTask，ResponseCode=null 获取DelegateExecution中的app_rules，更新DB的appRuleTask，失败转错误处理，成功继续

当DelegateExecution对象中app_rules的值为空时：

3.2 delete task table in db with success info

tasks.AppInstanceInfoDbAdapter operationType=deleteAppRuleTask 根据租户id和app id，从DB上删除appRuleTask信息。

4. Update record AppInstanceInfo DB

tasks.AppInstanceInfoDbAdapter operationType=update, operational_status=Created 将DB中的appInstance记录状态更新为Created

5. Add application instance to inventory

tasks.InventoryAdapter inventory=application, operType=ADD, status=Created 调用inventory接口 POST /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps,想inventory中添加实例信息

6. Send process flow error response

tasks.ProcessflowResponse responseTpye=success 执行success分支，向上下文添加resp和resp code

错误处理流程：

1. Send process flow error response

bpmn.tasks.ProcessflowResponse responseType=failure 向上下文写入错误码和resp

2. Update record AppInstanceInfo DB

bpmn.tasks.AppInstanceInfoDbAdapter operationType=update，operational_status=Create failed 通过上下文从DB中获取appInstance记录后，更新记录状态

3. Add application instance to inventory

bpmn.tasks.InventoryAdapter inventory=application,operType=ADD,status=Create failed 从上下文读值mecHost、tenantId、appInstanceId，appName和appPackageId,构造请求，调用inventory接口POST /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps，其中status为Create failed

总结

CreateApplicationInstance整体的过程其实是一个写DB的过程，通过入参，解析出package等信息，通过和inventory交互，做一些依赖检查，更新自身的appInstance和appRule记录，并最终向inventory推送。

实例化实例

入口代码

app实例化的接口定义位于

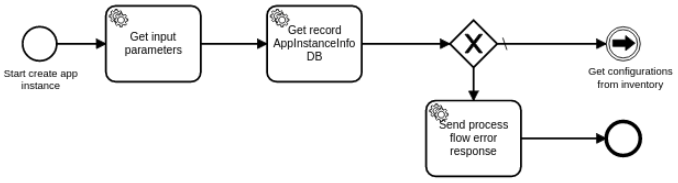
```
@ApiOperation(value = "Instantiate application instance", response = AppoResponse.class)
@PostMapping(path = "/tenants/{tenant_id}/app_instances/{app_instance_id}",
produces = MediaType.APPLICATION_JSON_VALUE)
@ApiResponses(value = {@ApiResponse(code = 201, message = "request accepted ", response = AppoResponse.class),
@ApiResponse(code = 500, message = "internal server error", response = String.class)
})
@PreAuthorize("hasRole('MECM_TENANT') || hasRole('MECM_ADMIN')")
public ResponseEntity<AppoResponse> instantiateAppInstance(
 @ApiParam(value = "access token") @RequestHeader("access_token") String accessToken,
 @ApiParam(value = "tenant id") @PathVariable("tenant_id")
 @Pattern(regexp = Constants.TENENT_ID_REGEX) @Size(max = 64) String tenantId,
 @ApiParam(value = "application instance id")
 @PathVariable("app_instance_id") @Pattern(regexp = Constants.APP_INST_ID_REGX)
 @Size(max = 64) String appInstanceId,
 @ApiParam(value = "Instantiate application instances")
 @Valid @RequestBody(required = false) AppInstantiateReqParam instantiateParam) {

 logger.debug("Application instantiation request received...");

 return appoService.instantiateAppInstance(accessToken, tenantId, appInstanceId, instantiateParam);
 }
```

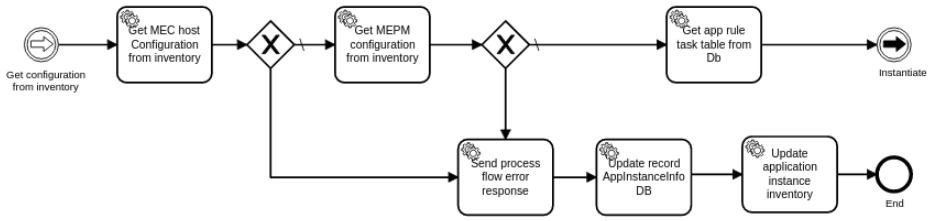
函数实现上主要就是根据DB中的内容，启动instantiateApplicationInstance流程：

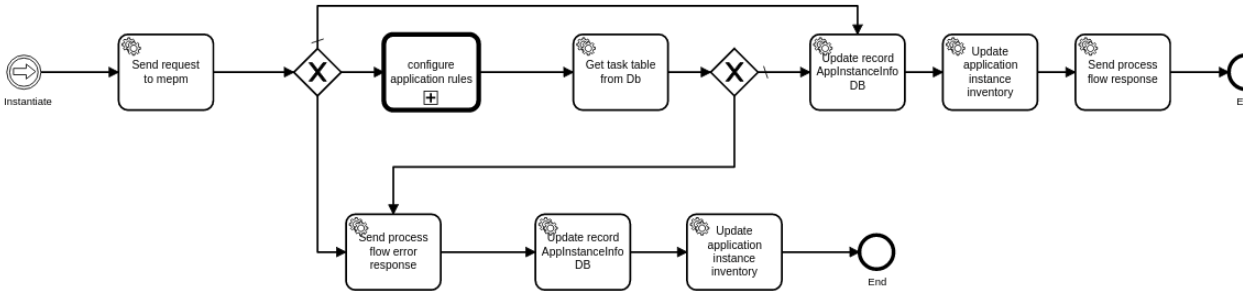
```
@Override
public ResponseEntity<AppoResponse> instantiateAppInstance(String accessToken, String tenantId,
String appInstanceId,
AppInstantiateReqParam instantiationParams) {
LOGGER.debug("Application instantiation request received...");
AppInstanceInfo appInstanceInfo = appInstanceInfoService.getAppInstanceInfo(tenantId, appInstanceId);
String operationalStatus = appInstanceInfo.getOperationalStatus();
//...param check
Map<String, String> requestBodyParam = new HashMap<>();
 requestBodyParam.put(Constants.TENANT_ID, tenantId);
 requestBodyParam.put(Constants.APP_INSTANCE_ID, appInstanceId);
 LOGGER.debug("Instantiate input params: {}", requestBodyParam);
 requestBodyParam.put(Constants.APPRULE_TASK_ID, appInstanceId);
 requestBodyParam.put(Constants.ACCESS_TOKEN, accessToken);
 if (instantiationParams != null && !instantiationParams.getParameters().isEmpty()) {
 requestBodyParam.put(Constants.INSTANTIATION_PARAMS,
 new Gson().toJson(instantiationParams.getParameters()));
 }
 //...启动流程instantiateApplicationInstance
 processflowService.executeProcessAsync("instantiateApplicationInstance", requestBodyParam);
 return new ResponseEntity<>(new AppoResponse(HttpStatus.ACCEPTED), HttpStatus.ACCEPTED);
 }
```

业务流程

instantiateApplicationInstance的整体过程与上一节类似，流程图如下：







主要涉及三个流程：

1. **Start create app instance**
2. **Get configuration from inventory**
3. **Instantiate**

Start create app instance

1. Get input parameters

tasks.GetRequestInputs　　requestAction=InstantiateAppInstance　　给流程上下文赋值accessToken, tenantId, appInstanceId, appRuleTaskId

2. Get record AppInstanceInfo DB

tasks.AppInstanceInfoDbAdapter　operationType=get　　根据tenantId和appInstanceId获取appInstance的db记录，赋值给上下文

错误处理流程：

1. Send process flow error response

tasks.ProcessflowResponse　responseType=failure　向上下文赋值错误码和错误信息

Get configuration from inventory

1. Get MEC host Configuration from inventory

tasks.InventoryAdapter　　inventory=mecHost　　根据mectHost和tenantId，调inventory接口GET /inventory/v1/mechosts/{mec_host}，得到mepmIp以及mecHost上的能力列表，赋值给上下文

2. Get MEPM configuration from inventory

tasks.InventoryAdapter　　inventory=mepm　　根据mepmIp和tanantId，调inventory接口GET /inventory/v1/mepms/{mepm_ip}，获取mepm的port，写入上下文

3. Get app rule task table from Db

tasks.AppInstanceInfoDbAdapter　operationType=getAppRuleTask　　从上下文获取appRuleTaskId和tanantId, 查db得到appRuleTaskInfo, 赋值流程app_rules和app_rule_status

错误处理流程：

1. Send process flow error response

tasks.ProcessflowResponse　responseType=failure　向上下文赋值错误码和错误信息

2. Update record AppInstanceInfo DB

tasks.AppInstanceInfoDbAdapter　operationType=update,operational_status=Instantiation failed　从上下文中取出appInstanceInfo信息，写入error状态字段，更新DB

3. Update application instance inventory

tasks.InventoryAdapter　inventory=application,operType=UPDATE,status=Instantiation failed 调inventory接口GET /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps/{app_instance_id}获取appInstance在inventory中的记录，再调用inventory接口PUT /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps/{app_instance_id},更新DB status字段

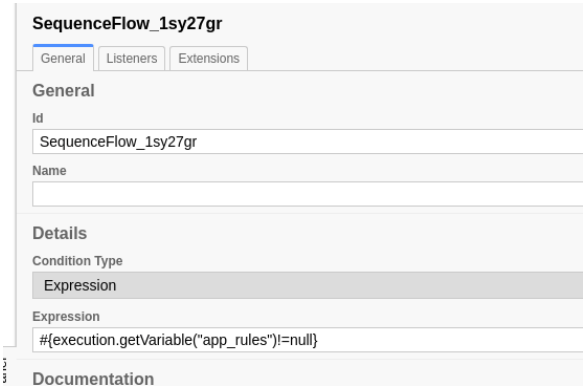
Instantiate

1. Send request to mepm

tasks.MepmAdapter　　action=instantiate　　从上下文获取appInstanceInfo和实例化参数appInstantiationParams，封装appInstReq，其中包括了mecHostIp, packageId, appName和初始化参数。**调用lcm接口 POST {mepmIp:port}/lcmcontroller/v1/tenants/{tenant_id}/app_instances/{app_instance_id}/instantiate,该接口为实例化的实现接口。如果成功调用，删除本地的appPkg包**

2. configure application rules

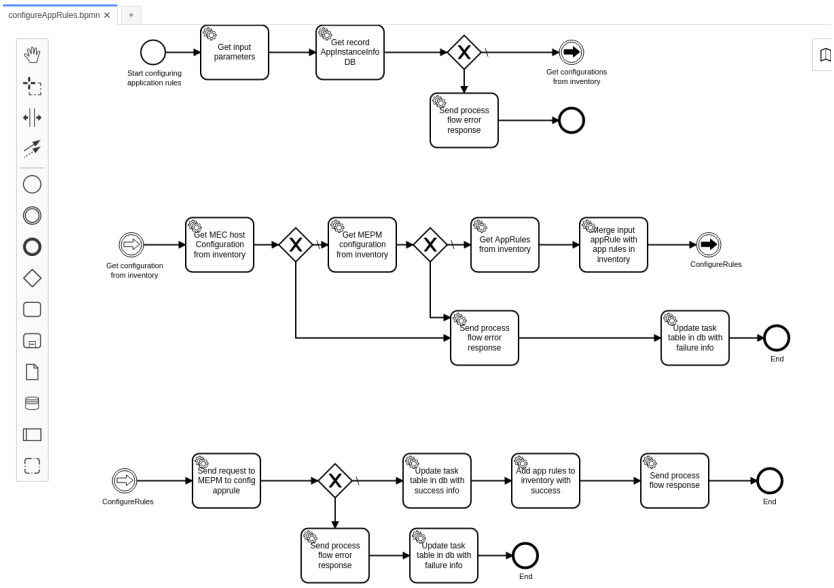
接下来将做一个判断：如果上下文的app_rules不为空，则引入子流程configureAppRules；否则，直接跳到节点3.Update record AppInstanceInfo DB:



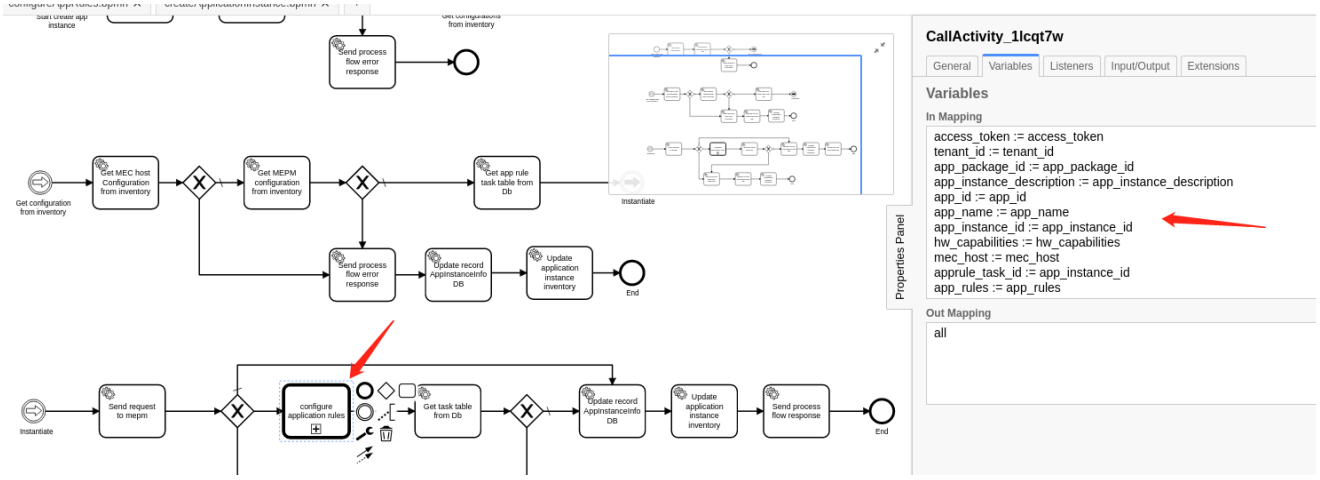
其中，app_rules即在app从developer-be发布时，配置的dns rule与traffic routing等信息

2.1 子流程configureAppRules

子流程的描述位于/resources/bpmn.mainprocess/configureAppRules.bpmn：



在进入流程之前，父流程向其上下文初始化了以下变量：



子流程的具体工作为：

1. Get input parameters tasks.GetRequestInputs requestAction=ConfigureAppRule 向流程上下文赋值各种参数，比如appInstanceId tanentId等，具体变量见上图
2. Get record AppInstanceInfo DB tasks.AppInstanceInfoDbAdapter operationType=get 调用DB，获取appInstanceInfo并赋值给上下文

3. Get MEC host Configuration from inventory　tasks.InventoryAdapter　inventory=mecHost　取出上下文中的mecHost字段，调用inventory接口GET /inventory/v1/mechosts/{mec_host}获取mepmIp和mecHost上的mep能力，赋值上下文

4. Get MEPM configuration from inventory　tasks.InventoryAdapter　inventory=mepm　从上下文取出mepmIp,调用inventory GET /inventory/v1/mepms/{mepm_ip}接口得到mepmPort，赋值上下文

5. Get AppRules from inventory　tasks.InventoryAdapter　inventory=apprules,operType=GET　从上下文获取appInstanceId 调用inventory GET /inventory/v1/tenants/{tenant_id}/app_instances/{app_instance_id}/appd_configuration，将返回赋值给上下文inventory_app_rules

6. Merge input appRule with app rules in inventory　tasks.Utils　utilType=mergeAppRules　从上下文分别获取appRules和inventoryAppRules，主要逻辑为合并两类rule，当rule有重合，使用inventoryAppRules，当appRules中没有inventoryAppRules，则向appRules增加。并将最后的结果appRules添加入上下文，key为updated_app_rules。

7. Send request to MEPM to config apprule　tasks.MepmAdapter　action=configureAppRules　从上下文取出updated_app_rules的值，调用 apprulemgr的/apprulemgr/v1/tenants/{tenant_id}/app_instances/{app_instance_id}/appd_configuration接口，该接口在实现上，apprulemgr会调用mep去执行实际的策略创建

8. Update task table in db with success info　tasks.AppInstanceInfoDbAdapter　operationType=updateAppRuleTask,tabel=appRuleTask　从上下文读取上一步调用apprulemgr的resp，如果成功，将封装的appRuleTaskInfo更新进对应租户tenantId的DB记录

9. Add app rules to　inventory with success　tasks.InventoryAdapter　inventory=apprules,operType=ADD,status=success　调用inventory的/inventory/v1/tenants/{tenant_id}/app_instances/{app_instance_id}/appd_configuration，将mep上创建成功的updated_app_rules推送至inventory保存

10. tasks.ProcessflowResponse　responseType=success　上下文写入success记录

3. Get task table from Db

tasks.AppInstanceInfoDbAdapter　operationType=getAppRuleTask　从上下文获取appRuleTaskId和tenantId，查DB得到appRuleInfo,信息写入DB

4.Update record AppInstanceInfo DB

tasks.AppInstanceInfoDbAdapter　operationType=update, operational_status=Instantiated　从上下文中取出appInstanceInfo信息，写入Instantiated状态字段，更新DB

5.Update application instance inventory

tasks.InventoryAdapter　inventory=application, operType=UPDATE, status=instantiated，　调inventory接口GET /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps/{app_instance_id}获取appInstance在inventory中的记录，再调用inventory接口PUT /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps/{app_instance_id},更新DB status字段为instantiated

6. Send process flow response

tasks.ProcessflowResponse　responseType=success　上下文写入success记录

错误处理流程：

1. Send process flow error response

tasks.ProcessflowResponse　responseType=failure　向上下文赋值错误码和错误信息

2. Update record AppInstanceInfo DB

tasks.AppInstanceInfoDbAdapter　operationType=update,operational_status=Instantiation failed　从上下文中取出appInstanceInfo信息，写入error状态字段，更新DB

3. Update application instance inventory

tasks.InventoryAdapter　inventory=application,operType=UPDATE,status=Instantiation failed 调inventory接口GET /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps/{app_instance_id}获取appInstance在inventory中的记录，再调用inventory接口PUT /inventory/v1/tenants/{tenant_id}/mechosts/{mec_host}/apps/{app_instance_id},更新DB status字段